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# On Science, Scientists, and Scientific Vocabulary: Commentary on Harrison's "The Representative Animal"

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In "The Representative Animal," Michael Harrison (this issue) argues that animal behavior is worthy of study in its own right and that such study will necessarily focus on the differences in the ways different species respond to particular features of the environment to which they have been adapted through natural selection. I am confident that no reader of this journal would argue that such study is irrelevant or inadvisable. But in order to be explicit, nothing I say in commenting on Harrison's article should be construed as devaluing the work of scientists whose primary interest is in understanding the ways in which various species differ from one another behaviorally.

Although it is clear that Harrison believes it is possible to examine the behavior of animals of one species for what we may learn about the behavior of other species, readers may come away with a bias against studying nonhuman animal behavior for the purpose of formulating behavioral principles that are generalizable across many species, including humans. I do not believe that such a conclusion would be justified, because it confuses a number of issues pertaining to the nature of scientific activities.

One reason that science is interesting is that there are so many different kinds of questions one can ask of nature. The work of particular scientists is usually confined, first, to a particular range of phenomena and, second, to a particular kind of question. Thus, Ivan Pavlov seems to have been attracted to the workings of the central nervous system as the phenomena of primary interest and the questions he asked were designed to delineate a (nervous system) process that accounted for acquired reflexes. He probably was not particularly interested in dogs per se.

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Unlike Pavlov, John B. Watson seems to have been attracted to a range of phenomena roughly delineated by the term *behavior of organisms*. Also unlike Pavlov, the questions he asked had to do with the ways in which behavior differed from individual to individual and species to species. Watson appears to have been content to accept and refine Pavlov's identification of conditioning as the modus operandi underlying observed differences in human behavior.

B. F. Skinner, like Watson and unlike Pavlov, focused his attention on the behavior of organisms; but unlike Watson and like Pavlov, Skinner's scientific focus was not on the particulars of behavior. Rather, he focused on identifying processes that account for similarities and differences in individual behavior that are not directly attributable to the history of an organism's species nor to Pavlovian conditioning.

The purpose of the above examples is to illustrate two facts: First, scientists interested in the *same* general range of phenomena, let us say the behavior of organisms, not only ask different questions of nature; they sometimes ask different *kinds* of questions as well. Second, scientists interested in *different* phenomena sometimes ask the *same kinds* of questions. Like Watson and Skinner, Harrison's scientific interest centers on behavioral phenomena. Like Watson and unlike Skinner and Pavlov, the kinds of questions that interest Harrison are those that concern species-specific similarities in behavior and those that delineate differences in the ways different organisms and different species respond in similar situations.

The conceptual frameworks of various sciences are grounded in principles (or laws) that are spatiotemporally unrestricted (Hull, 1984), or structural abstractions (Lee, 1988). The principles apply to a specified domain of phenomena (e.g., living organisms or acquired behavior) and are formulated as a result of observations of relations among particulars of the domain; but the principles transcend the particulars observed and "are comprehensible without reference to any single particular" (Lee, 1988, p. 122). In evolutionary biology, the structural abstractions are about organic evolutionary *processes*. Once principles were formulated, they were used to gain understanding of (explain) the *content* of the organic world. Thus the principle of natural selection is used in explaining bipedality of humans, panda's thumbs, and so forth.

However, a content-oriented biologist interested in accounting for human bipedality or the panda's thumbs must go beyond process and attempt to specify the particulars of earlier environments as they interacted with earlier forms, eventually resulting in particular species characteristics. Gewirtz and Petrovich (1982) provide a number of examples showing that some similarities in species-specific characteristics of distantly related species are often a function of the survival contingencies characteristic of particular ecological niches (rather than a function of their relation to a common ancestor). That is, the similarities in behavioral characteristics of those species are analogous rather than homologous within a framework of organic evolution.

A well-developed conceptual framework in behavior analysis would be based, similarly, on a small number of principles that explain a vast range of ontogenic behavioral content. Any behavioral content acquired during the lifetime of an individual organism rests, of course, on behavioral processes that were acquired during the history of the species to which the organism belongs. Therefore, behavioral content of ontogenic origin must be distinguished from behavioral processes that operate during ontogeny but are themselves of phylogenic origin.

At the behavioral level of analysis, two members of a single species may behave in the same way under the same conditions. It is reasonable to call the behavioral content wholly innate if that content can be shown to be solely a function of the history of the species and a current environment. In this case, the behavioral content of two members of a species would be homologous at the behavioral level. On the other hand, if similarities in any particular behavioral content of two organisms (e.g., humans) could be shown to be entirely a function of behavioral processes occurring during the lifetime of the individuals, that behavior of the two organisms would be analogous (although the organisms would be behaviorally homologous with respect to the behavioral processes accounting for that content).

There is a very strong tendency to consider similarities in human behavioral content as evidence that the behavioral content is innate (i.e., due directly to the species-specific biological characteristics of the organisms that resulted from natural selection). A case in point is the attachment behavior of human infants, whereby most infants show distress when their caretaker leaves them. Research reported by Gewirtz and Pelaez-Nogueras (1991) strongly suggests that the attachment behavior observed in different human infants is analogous, not homologous. That is, the behavioral content designated as *attachment* is not an innate given but rather is a function of behavioral processes that occur during an infant's lifetime (specifically, reinforcement and stimulus control).

The questions Harrison is interested in are questions about behavioral content, questions that focus on how species differ in the way they behave under particular conditions. The experimental work of Harrison and his colleagues does indeed suggest that "performance in the natural and unnatural arrangements thus depended upon different processes" (Harrison, 1994, p. 216). Important to note is that the different processes were selection processes in two different domains. The process of natural selection accounted for the apparently unlearned reaction "approach sound source"; but the process of reinforcement accounted for the continued approach to a particular sound (stimulus control of that particular sound over frequency of approach behavior).

Interestingly, the ontogenic reinforcement contingencies were able to override the phylogenic proclivity to "approach sound source," although it took 20 sessions for the ontogenic contingencies to prevail. Also interesting is that the animals immediately approached only novel sound sources. Four sessions were required for nonnovel sound sources to acquire control over approach behavior. It seems possible (perhaps likely) that when these sounds were novel, the animals made some attempt to approach and no reinforcement occurred. Therefore, those particular sounds acquired some $S^{\Delta}$ properties. When they were introduced in the experimental context, it took some time for the phylogenic control to reassert itself.

This brings us to the issue of the evolution of behavior. The term *evolution* is used with respect to all kinds of phenomena, but only in biology are the processes that account for evolution more or less generally accepted. Further, only in biology are the units of analysis fairly well understood. Thus, for most people, "the evolution of behavior" means changes in behavioral repertoires of various species that result from mutation, natural selection, and other organic evolutionary processes. The unit of analysis is species (with their member organisms), and the explanatory principles are those of evolutionary biology.

As has been pointed out (Skinner, 1984), the principles of evolutionary biology account not only for some of the behavioral content observed in members of particular species but also for the existence of processes that operate at the behavioral level during the lifetime of individual organisms. With regard to the operation of these processes (e.g., reinforcement) in the origin of some behavioral content, many species appear to be homologous. That does not mean, of course, that they are the same in all particulars. It does suggest, however, that the part of behavioral content of individual organisms that is *not* directly accounted for by organic evolutionary processes must be attributed to processes that occur during ontogeny.

It has further been suggested that the behavioral processes of reinforcement and stimulus control can, in turn, account for emergent processes that are specific to those individual organisms with a particular kind of ontogenic history—one of arbitrarily applicable relational framing (Hayes, 1991). Although relational framing is characteristic of human repertoires and has not been unequivocally demonstrated in other species (but see Schusterman & Kastak, 1993), it is an open question as to whether only humans are capable of such behavior. As in the case of attachment behavior, the ubiquity of relational framing in humans may be a function of the ubiquity of certain similarities in reinforcement histories. Specifically, the requisite history may require a verbal community to provide contingencies of reinforcement in which arbitrary stimuli enter into reversible relations with features of the environment. If this turns out to be the case, relational framing would be a byproduct of evolving verbal practices in human cultures. All that may be required for nonhumans to engage in such behavior would be a verbal community to arrange the appropriate contingencies.

It seems likely that the processes that account for human behavioral content include: (a) the processes of organic evolution that possibly directly account for some behavioral content and that certainly account for behavioral processes that operate during the lifetime of individual organisms, (b) the processes that occur during ontogeny and account for the individualized behavioral content of humans and other organisms equipped with the emergent behavioral processes, and (c) possible processes emerging in the repertoires of individual humans that are attributable to culturally programmed behavioral contingencies.

If behavioral content can be attributed to some combination of these three different kinds of processes (and it is surely attributable in members of many species to some combination of the first two), then it is critical that the processes that occur at each level be understood in their own right. Only after we acquire some scientific understanding of these various processes will we be able to make sense of the ways in which they combine to produce the behavioral content of individual organisms.

The issues discussed above pertain to the philosophy of a science of behavior. Much of the work of philosophies of particular sciences entails developing a vocabulary that delineates the phenomena of interest in useful ways. Recent work in the philosophy of biology provides examples of the kind of work that has aided development of evolutionary biology's conceptual framework (e.g., Brandon & Burian, 1984; Mayr, 1988; Sober, 1993).

Harrison's article provides some examples of vocabulary issues that could stand some attention. Harrison (p. 210) says "each species brings a different behavioral phenotype to the experiment." In this usage, a behavioral phenotype appears to refer to those behavioral characteristics that all members of a species have in common. But each member of a species that learns has a unique behavioral phenotype to the extent that the particulars of its ontogenic history differed from others'. It is generally accepted that the behavioral phenotype of organisms who learn is a product of interaction between its genotype and particular ways in which environmental events have interacted with the continuously changing phenotype. Thus a species' phenotype is not the same thing as an organism's phenotype. Similarly, a species' genotype is not the same thing as an organism's genotype. The species' genotype is identified in terms of what all members have in common (most obviously number and sequence of chromosomes). Within the parameters of the species' genotype, member organisms vary among themselves with respect to genotype, thereby providing the variation so necessary for evolution.

Another confusing locution is "species-specific behavior is all the animal . . . has" (Harrison, 1994, p. 210). If we are talking about behavioral content, many animals have organism-specific behavior as well. And in the case of some species (notably, perhaps, humans) there may be organism-specific behavioral processes as well as organism-specific behavioral content.

Similarly, the term *behavioral environment* can be used as Harrison used it—referring to those features of the environment that affect an organism because of the way the organism is constructed. "Thus, one species is likely to abstract certain stimulus features from the environment, be subject to particular stimulus filtering, and have a strong tendency to emit a number of characteristic responses" (Harrison, 1994, p. 210). In this usage, the environment functions as it does as a result of the contingencies of natural selection accounting for species characteristics. The term *behavioral environment* can also be used in Glenn's (1991, pp. 46–47) sense—referring to those features of the environment that have function with respect to the repertoire of a particular organism as a result of the particular combination of phylogenic and ontogenic contingencies that account for that unique repertoire.

In the first usage, the behavioral environment of intact members of a species would be very similar and the behavioral environments of different species would differ. In the second usage, the behavioral environments of intact members of a species would differ, sometimes dramatically. In the human case, behavioral environments may differ dramatically even when the physical environment for two humans is structurally very similar. Like *phenotype* and *genotype,* the term *behavioral environment* is used in different ways. Such multiple usages make life difficult but they are common in every science. It seems important, however, that clarifications be made. Fortunately, behavior analysts (e.g., Hineline, 1980) have begun to recognize that the language of their science may be as important as their data, because it helps them to make good use of their data.

In closing, I return to the particular kind of confusion with which this commentary began. Scientists who share an interest in a particular range of phenomena but differ with respect to the kind of questions they are trying to put to nature may find themselves puzzled by what their colleagues fail to take into account. However, behavioral science will be advanced if some scientists follow in the content-oriented footsteps of Watson and Harrison and others follow in the process-oriented footsteps of Pavlov and Skinner in the kinds of questions they put to nature. No doubt, scientists having both kinds of interests will be puzzled by what the others seem to ignore. Also, it may help if some scientists follow in the footsteps of Mayr (1988) and Ghiselin (1974), working to sort out the confusions inherent in the vocabulary of their particular science.

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